

# Rabies in Canada: History, Epidemiology and Control

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## Abstract

Rabies first became evident in Canada during the late 18th and early 19th centuries. However, only a few sporadic outbreaks, mainly in domestic animals, were noted before 1945.

Rabies in foxes spread into the Canadian provinces from the Arctic regions during the late 1940s. The disease gradually died out in most areas except Ontario. A second major outbreak, involving skunks, progressed from North Dakota into the Prairie provinces during the late 1950s and 1960s. Today, the major problem areas in Canada with respect to rabies are southern Ontario, which accounts for 85% of the Canadian diagnoses, and the Prairie provinces where rabies is enzootic in skunks.

Rabies is rare in humans in Canada; however more than 40,000 cases have been reported in wild and domestic animals since 1958. Control of rabies is currently being undertaken through vaccination of domestic animals and wildlife, population reduction of wildlife vectors, and human preexposure rabies vaccination.

## Résumé

### Histoire, épizootiologie et contrôle de la rage, au Canada

Les premiers cas de rage, au Canada, remontent à la fin du 18<sup>e</sup> siècle et au début du 19<sup>e</sup>. On n'enregistra toutefois que quelques éruptions qui impliquaient surtout des animaux domestiques avant 1945.

Vers la fin des années 1940, la rage vulpine se répandit des régions arctiques aux provinces canadiennes. La maladie disparut ensuite progressivement de la plupart des régions, à l'exception de l'Ontario. Vers la fin des années 1950, une deuxième éruption majeure progressa du Dakota Nord et affecta les mouffettes des provinces des prairies, au cours de la décennie suivante. Actuellement, les régions les plus touchées sont le sud de l'Ontario, où on dénombre 85% des cas de rage de tout le Canada, et les provinces des prairies, où la maladie existe à l'état enzootique, chez les mouffettes.

Les cas de rage humaine sont rares au Canada, en dépit du fait que, depuis 1958, on en a diagnostiqué au-delà de 40,000 cas, chez les animaux domestiques et sauvages. Le contrôle de la maladie se fait par la vaccination des animaux domestiques et sauvages, la réduction des animaux sauvages qui en sont les vecteurs et la vaccination prophylactique des gens dont le travail comporte un risque particulier de contamination.

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**R**abies is an acute infectious disease of the central nervous system caused by a lyssa virus. Generally, rabies infection occurs from the bite of an infected animal; however, transmission is also possible by ingestion of infected tissue, aerosol inhalation, or from corneal transplants (1).

The virus usually enters muscle tissue via saliva and progresses through nerves to the central nervous system by the movement of cytoplasmic fluids. Viral replication takes place in the spinal cord as the disease spreads to the brain, where considerable multiplication occurs. Once clinical signs develop, the virus is usually, but not always, excreted in the saliva, providing an effective route of transmission. Following infection in the brain, replication of rabies virus also occurs in non-nervous tissues (2). Virus may also replicate in muscle cells at the site of infection or be present in the saliva or salivary glands several days before clinical signs appear (3,4).

The incubation period for rabies is quite variable and is no doubt dependent on the particular strain of rabies virus. In domestic animals and wildlife, signs usually occur two to six weeks after infection. However, in humans, incubation periods may range from one to three months and have even been documented at more than a year (2). In general, the incubation period depends on the amount and virulence of infectious virus transmitted, and the site of inoculation. Resistance to rabies infection is also possible as evidenced by the presence of rabies neutralizing antibodies in some species (5).

Animals usually exhibit either the "furious" or "dumb" form of rabies or a combination of the two; however, brain material from skunks (*Mephitis mephitis*) has been found positive for rabies by a fluorescent antibody test even though the animals appeared clinically normal prior to euthanasia (R. C. Rosatte, unpublished data). During furious stages, rabid animals will attack humans, other animals, or even inanimate objects. However, during the "dumb" stage, the animal is generally docile and may be paralyzed.

## Early History and Epizootiology

Rabies was probably present in dogs during the late 1700s in Quebec; however, the first two recorded cases of rabies in Canada were both in humans during the 19th century — one in Ontario (1819) and the other in Quebec (1839). During the first part of the 20th century, sporadic outbreaks of rabies occurred in domestic animals in most of the Canadian provinces. The domestic dog accounted for the majority of rabies cases in Canada before 1945 (6,7,8).

An outbreak of rabies in foxes (*Alopex lagopus*, *Vulpes vulpes*) began in the Arctic regions during the 1940s and spread into the Canadian provinces in the early 1950s. In 1952, rabies swept through the province

of Alberta in less than a year (9). The major vectors involved were foxes and coyotes (*Canis latrans*). The epizootic also occurred in British Columbia, Saskatchewan and Manitoba during the same period (7).

The Arctic epizootic entered Quebec during the early 1950s and moved into Ontario in 1954 where it eventually became enzootic in foxes and skunks (10,11). Rabies in wildlife spread through Quebec reaching New Brunswick in 1966 (7).

A second major epizootic which involved skunks, moved into the Prairie provinces from North Dakota during the late 1950s. Skunk rabies spread across Manitoba into Saskatchewan during the 1960s and reached Alberta in 1971 (12, 13). Skunk rabies has been enzootic in the Prairie provinces since that time, although the disease in skunks was controlled during the early 1980s in Alberta (14).

### Current Status of Rabies in Canada

During the last two decades (1965–1985) the number of rabies cases diagnosed in Canada has fluctuated between 1,400 and 2,500. Wildlife accounted for 75% of the diagnoses (15). Generally, the prevalence of rabies or percent-positive cases has remained relatively constant, that is, the more submissions the more positive diagnoses (16).

Approximately 85% of rabies cases in Canada are reported from Ontario. More than 40,000 diagnoses were made since 1958 in that province (Table 1). Annual positive cases fluctuated between 900 and 2,100 during the last two decades (1965–1985) (7; R.C. Rosatte, unpublished data). However, in 1986, an unprecedented 3,526 positive diagnoses were reported in Ontario. Foxes and skunks accounted for the majority (68%) (Table 2). The increase in positive cases during 1986 is apparently real (not due solely to increased submissions) as the prevalence of rabies in total submitted specimens actually increased over previous years (K. Charlton, unpublished data).

In the other provinces of Canada, rabies has not been reported or is present at low levels, except in Saskatchewan. That province usually accounts for 10% of the rabies diagnoses in Canada. During 1986, 90% (396) of the reported cases in Saskatchewan were in skunks (Table 2).

Incidence of rabies at the species level varies geographically in Canada. In rural areas of southern Ontario, skunks and red foxes are the major vectors. However, skunks are the more important carrier in urban areas (17). The major rabies vector in the Prairie provinces is the striped skunk; rabies is rarely diagnosed in foxes. Most of the rabies cases reported in British Columbia are in bats (18).

The rabies enzootic areas in Ontario, the Prairie provinces and British Columbia appear to be distinct from one another. That is, the rabies strain in foxes and skunks in Ontario is different from the skunk rabies strain in the Prairie provinces as determined by monoclonal antibody testing. As well, the strains of bat rabies are totally different from any terrestrial mammal rabies strains (19,20,21).

**TABLE 1**  
**Rabies Cases in Ontario — 1958–1986<sup>a</sup>**

Species	No. Rabid	% of Total
Red fox	17,982	44.3
Striped Skunk	7,692	19.0
Cattle	7,742	19.0
Dog	2,161	5.3
Cat	1,932	4.8
Sheep, pig, goat	1,400	3.5
Horse	693	1.7
Bats	402	1.0
Coyote/wolf	244	0.6
Raccoon	236	0.6
Others <sup>b</sup>	77	0.2
Total	40,561	100

<sup>a</sup>Tables from Agriculture Canada records

<sup>b</sup>Others include groundhog, deer, bear, muskrat, bison, fisher squirrel, elk, weasel, vole, mink, rabbit, donkey

### Human Rabies

Rabies in humans is rare in Canada compared to areas such as India where more than 20,000 cases occur annually (22). In underdeveloped countries such as India, the number of human rabies cases per million population is around 28 (22). The number for Canada per million approaches zero. Between 1925 and 1986, only 21 cases of rabies were diagnosed in

**TABLE 2**  
**Rabies in Canada — 1986<sup>a,b</sup>**

Province	Total	% of Total	Fox (n)	Skunk (n)	Cattle (n)	Dog (n)	Cat (n)	Bat (n)	Other <sup>c</sup> (n)
Ontario	3,526	85.4	1,650	722	595	130	150	45	234
Saskatchewan	440	10.7	0	396	24	3	10	5	2
Manitoba	74	1.8	5	57	6	3	1	0	2
Quebec	58	1.4	38	10	5	3	0	1	1
NWT	16	0.4	15	0	0	0	0	0	1
British Columbia	9	0.2	0	0	0	0	0	9	0
Alberta	7	0.1	0	1	0	0	0	6	0
Nova Scotia	1	<0.1	0	0	0	0	0	1	0
Total	4,131	100	1,708	1,186	630	139	161	67	240

<sup>a</sup>Data taken from Agriculture Canada monthly records

<sup>b</sup>Rabies cases were not reported from Prince Edward Island, New Brunswick, or Newfoundland during 1986

<sup>c</sup>Others include 69 sheep, 38 horses, 32 raccoons, 35 coyotes, 25 goats, 13 pigs, 10 wolves, 8 groundhogs, 2 rabbits, 1 bear, 1 bison

**TABLE 3**  
**Human Rabies in Canada — 1925–1986**

Years	Que.	Ont.	Sask.	N.S.	Alta.	Total
1925–1935	9	2	1			12
1936–1955		1				1
1956–1965	1	2				3
1966–1975		1	1			2
1976–1986	1			1	1	3
Total	11	6	2	1	1	21

humans in Canada (15) (Table 3). The majority of those were in Quebec (11 cases) and Ontario (6 cases). Only four cases have been reported since 1970, the most recent in Alberta in November of 1985 (15). Human rabies has not been recorded in Newfoundland, New Brunswick, Prince Edward Island, British Columbia, or Manitoba.

### Human Postexposure Treatment

Between 1980 and 1985, the number of people treated annually for rabies exposure in Canada has increased from 2,000/yr to about 2,800/yr (15). The majority (85–90%) of human exposures in Canada occur in Ontario; during 1980–1986, 16,201 people were treated in Ontario for exposure to possibly rabid animals (Table 4). Dogs and cats were involved in over half of the exposures, and foxes, skunks, and bats accounted for 20% (Table 4). The increase in the number of persons treated for rabies exposure is probably a result of an increased public awareness of rabies, multiple exposures per rabid animal, and greater availability of human diploid cell rabies vaccine.

Many of the animals causing a potential human exposure are not captured for rabies diagnosis. Therefore, it is not known whether the animals were actually rabid or not. Of the dogs and cats that cause human exposures and are available for diagnosis, less than 2% are rabid (16). No doubt many of the postexposure treatments are unnecessary. Regardless, one must assume that the animal causing the potential exposure was rabid if it was not available for diagnosis.

### Rabies Control in Canada

During the early part of the 20th century, rabies was controlled through muzzling orders and quarantine of dogs (7). However, since the 1950s, rabies control has been attempted through population reduction, vaccination of domestic animals and wildlife, and by allowing the disease to run its course.

#### Wildlife Control

**Population Reduction:** During the invasion of Arctic fox rabies into the Prairie provinces in the early 1950s, the province of Alberta implemented a massive population reduction campaign aimed at depressing the wildlife population. More than 100,000 foxes, coyotes, skunks, and other species were destroyed by poisoning, trapping, and shooting (9). Rabies was progressively eliminated from south to north in Alberta, yet the epizootic died out in Saskatchewan, Manitoba, and

British Columbia without control. The outbreak in those provinces, however, was not as intense as in Alberta as indicated by the number of diagnosed cases.

The population reduction program in Alberta was reinstituted during the 1970s and 1980s to combat an outbreak of rabies in skunks. Skunks were removed by trapping, shooting, poisoning, or gassing (13). Population reduction appears to have been effective in Alberta due to the isolated nature of the outbreaks, geographic barriers, and immediate control response after the initial outbreak was reported (14).

**TABLE 4**  
**Human Rabies Postexposure**  
**Prophylaxis/Animal Species Involved**  
**in Ontario — 1980–1986**

Species Involved	No. People Vaccinated	% of Total
Dog	5,264	32.5
Cat	3,334	20.6
Cattle	2,030	12.5
Other domestic	1,307	8.1
Red fox	1,880	11.6
Striped skunk	785	4.8
Bats	498	3.1
Other wildlife	1,103	6.8
Total	16,201	100

**Vaccination:** Ontario is currently the only Canadian province actively pursuing the control of rabies in wildlife through vaccination (23). Experiments have been conducted to investigate the oral immunization of foxes with vaccine-impregnated baits in the laboratory as well as in the field (24,25). The oral vaccine-baiting system currently being tested is fairly effective in foxes; however, the vaccine is ineffective in skunks. Experiments are underway to develop an oral vaccine that is effective on both skunks and foxes (20,26).

A tactic to control rabies in skunks and raccoons in urban areas is also being tested for feasibility in Ontario. Animals are live-trapped, vaccinated against rabies (Imrab inactivated rabies vaccine, Mérieux) intramuscularly, and released at the point of capture. Although quite labour intensive, the tactic appears feasible for the control of urban skunk and raccoon rabies (27).

#### Domestic Animal Rabies Control

Since the introduction of effective immunization, rabies in dogs and cats has decreased dramatically in Canada. During the first half of the 20th century, dogs accounted for 70–90% of the reported cases (7). Now, dogs account for less than 5% of the rabies diagnoses.

Although losses to the cattle industry are quite high, cattle are not usually vaccinated (7). Domestic animals that have been in contact with a suspected or known rabid animal may be quarantined for 40–60 days (livestock) or three to six months (pets). Dogs are quarantined for ten days in Ontario and 14 days in Quebec, Manitoba, Saskatchewan and Alberta after biting a human (28).

Dog control, elimination of strays, and vaccination have been the prime means of rabies prevention in Canada. Rabies vaccination clinics are held in some counties in Ontario. As well, vaccination of dogs and cats against rabies is compulsory in some areas of Ontario. Restrictions are also placed on the importation of dogs and cats; those imported from the United States must have a vaccination certificate dated within the last three years (28).

Currently, vaccination of pets is recommended in Canada (29). A recent survey in metropolitan Toronto, Ontario, indicated that 99% of the dogs and 94% of the cats were vaccinated against rabies; however, the vaccination status of dogs and cats in rural areas is largely unknown (R.C. Rosatte, unpublished data).

### Human Rabies Prevention

The human diploid cell vaccine (HDCV) is recommended for protection against rabies, especially for personnel involved in rabies diagnostic work or the collection and handling of field samples (28). Animal handlers, veterinarians, laboratory workers, and wildlife personnel should receive preexposure rabies vaccination (29,30).

Following a bite or scratch from a potentially rabid animal, recommendations include immediate washing of wounds with soap or detergent and water, followed by immediate medical attention, and immunization with vaccine and rabies immune globulin (29,30).

In the future, successful rabies control in Canada will have to focus on pet confinement and vaccination, control of stray animals, compulsory vaccination of domestic animals, and eradication of rabies from the rabies reservoir in wildlife.

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